

# Cell Phone Technologies

# Overview of Cell Phone Technologies

Cell phone technology refers to the specific technical specifications and standards used in cell phone service. There are many of these and they are continuously updated.

Early cell phones and systems were analog. Numerous standards evolved in the US and other countries. Today, most cell phone systems are of the digital 2G or 2.5G type but some 3G systems are already in operation.

The cell phone standards in the US are set by the Telecommunications Industry Association (TIA). The International Telecommunications Union (ITU) also helps develop cell phone and other communications standards worldwide.

The following is an overview of the US cell phone standards.

# Advanced Mobile Phone System (AMPS)

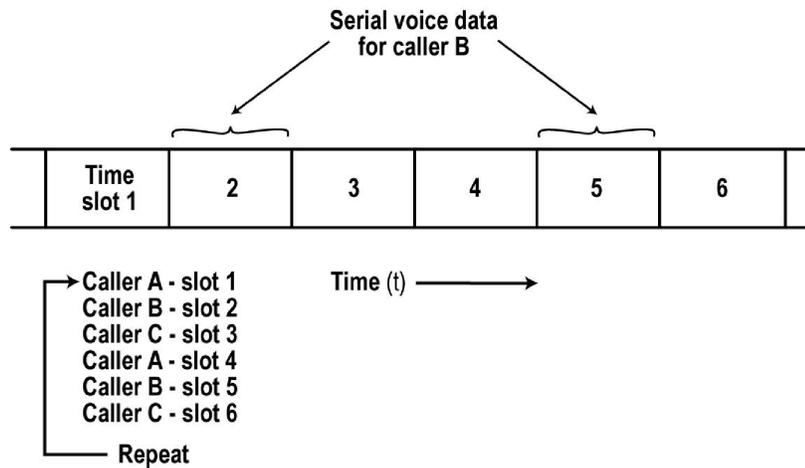
The original US cell phone system (1G) was an analog system called the advance mobile phone system (AMPS). It used the 800 – 900 MHz bands described earlier.

The access method was frequency division multiple access (FDMA) where the bands are divided into two bands of 832 30 kHz wide channels. One phone call occupied two channels, one from each band. The modulation was FM.

Early phones used frequency division duplexing. One channel was used for transmitting while the other was used for receiving. The two channels were spaced 45 MHz apart so that the transmitter in the handset did not interfere with the receiver in the handset. Filters kept the signals separated from one another.

AMPS is no longer widely used although most base stations still support it. The FCC has designated 2007 as the date by which all AMPS operations will be halted.

# Time Division Multiple Access (TDMA)



TDMA is the generic name given to the first US digital 2G cell phone system. This system is sometimes designated by its TIA standard number IS-54 or the newer version IS-136.

This system uses the same 30 kHz channels defined earlier.

The system allows three phone calls to be simultaneously transmitted in a single channel using time division multiplexing.

The format shown is that used in IS-136 TDMA.

# TDMA

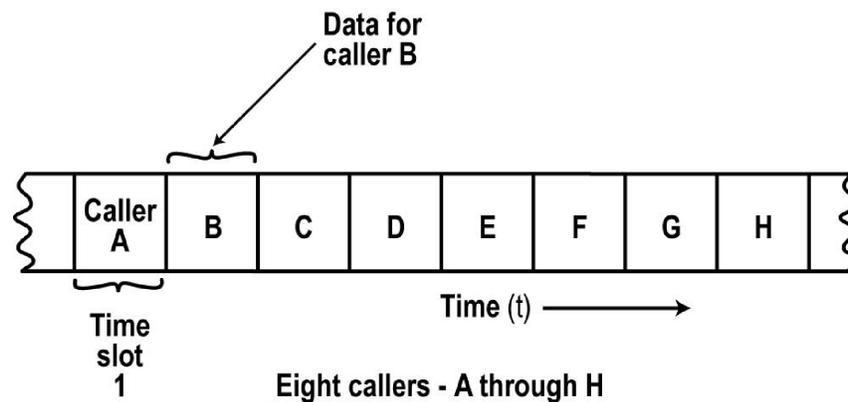
The serial data rate is 48.6 kbps.

The modulation is called differential quadrature phase shift keying (DQPSK). It is a special form of PSK that allows more bits to be transmitted in the same bandwidth. The 48.6 kbps signal is transmitted in the 30 kHz channel.

The duplex method is FDD.

TDMA systems are still widely used although they too are slowly being phased out in favor of newer 2.5G and 3G TDMA or CDMA systems.

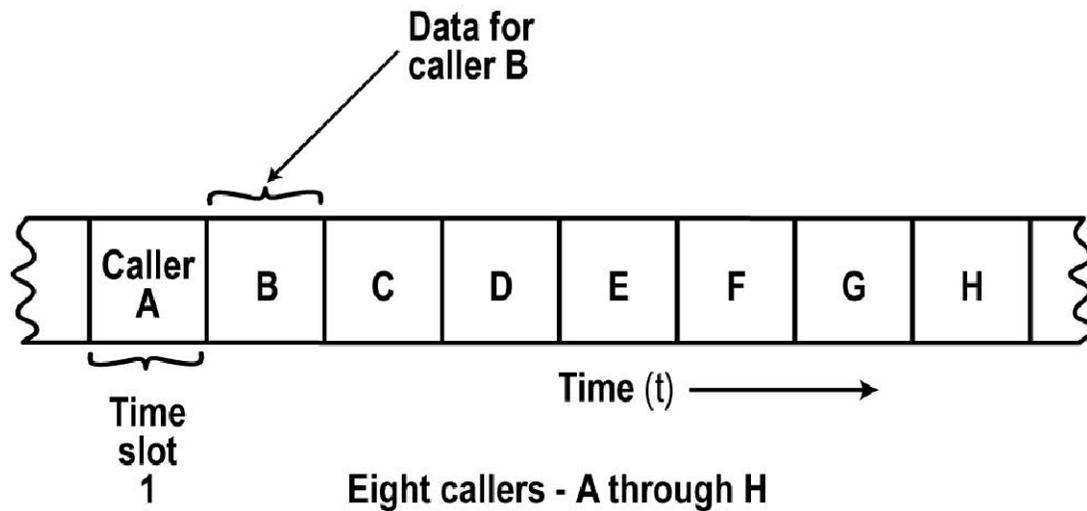
# Global System for Mobile Communications (GSM)



The global system for mobile communications (GSM) is a TDMA system that was originally developed in Europe where it is still the dominant system. It has also been widely deployed in the US and is a growing standard. The standard is set by the European Telecommunications Standards Institute (ETSI).

GSM uses 200 MHz wide bands and permits eight phone calls to be transmitted using time division methods in a single channel.

# GSM



GSM uses a special form of frequency shift keying (FSK) called Gaussian minimum shift keying (GMSK). It is more efficient than ordinary FSK and allows faster data rates in the 200 kHz channel. The data rate is 270 kbps.

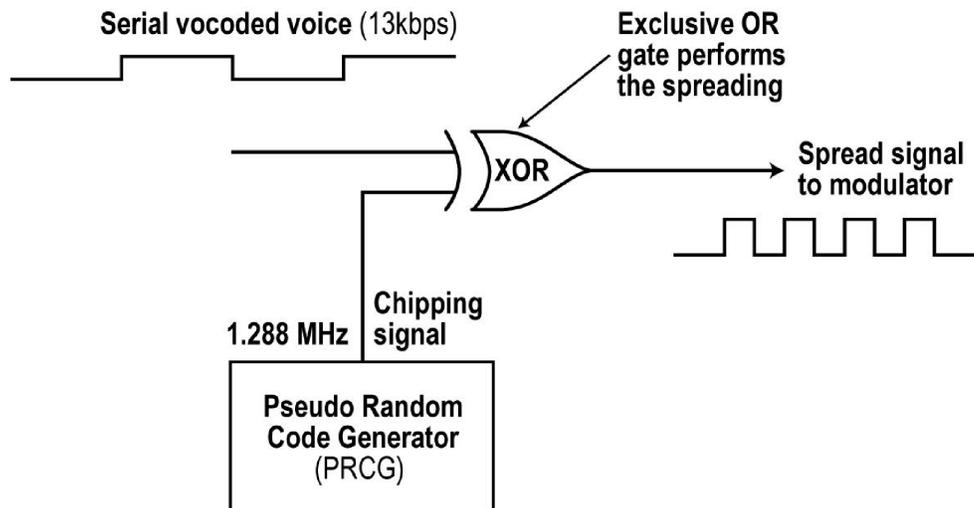
In the US, GSM is available from cell phone carriers Cingular and T-Mobile.

# GPRS and EDGE

GSM systems are 2G digital systems but many have been upgraded to 2.5G by the addition of a packet data capability called General Packet Radio System (GPRS). It allows the transmission of non-voice data in some of the time slots of the signal. This allows cell phone users to access the Internet, email, short message service, and even digital photos and video. Data transmission rate is typically in the 40 to 60 kbps range but some systems can achieve data rates up to about 115 kbps.

A further revised and updated addition to GPRS is called EDGE or Enhanced Data for Global Evolution. It also transmits data in one or more of the GSM time slots but uses a more efficient form of modulation called 8PSK where data is transmitted as one of eight different phase shifts of the carrier. Data rates to 384 kbps are possible.

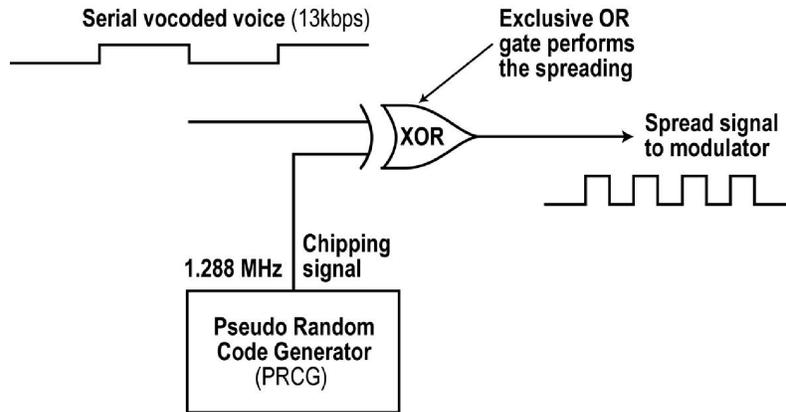
# Code Division Multiple Access (CDMA)



Another widely used cell phone standard is CDMA which uses spread spectrum. The original standard is designated IS-95 which was updated several times to IS-95A and B.

This system transmits direct sequence spread spectrum (DSSS) in a 1.25 MHz band. The chipping rate is 1.288 Mbps. The modulation is QPSK.

# CDMA Service



About 40 to 60 signals may occupy the same channel simultaneously.

CDMA was pioneered by a San Diego company Qualcomm. Qualcomm develops most of the chips that make up CDMA cell phones and base stations.

CDMA service is available in the US from Verizon and Sprint.

# CDMA2000

CDMA2000 is an upgraded version of the IS-95 standard to make fast packet data handling possible. This is a 2.5G standard although some versions put it in the 3G category.

CDMA2000 1xRTT is the first generation version that gives packet data transmission capability with speeds to 153 kbps.

Another version called 1xEV-DO can achieve a data rate to 307 kbps.

Both 1xRTT and 1xEV-DO use a single 1.25 MHz channel. A version called 3xRTT uses three 1.25 MHz channels for a total bandwidth of 3.75 MHz. Data rates to 2.4 Mbps can be achieved.

Today the 1xEV-DO is widely available but the higher rate systems have not yet been widely implemented.

## 3G and WCDMA

Third generation (3G) cell phones were originally defined by the ITU as those that can achieve a 2 Mbps data rate or more. This is referred to as the Universal Mobile Telephone Service (UMTS). The standard specifies wideband code division multiple access (WCDMA) that uses a 5 MHz channel and FDD. The standard is maintained by the Third Generation Partnership Project (3GPP). WCDMA has not been widely implemented because of the large amount of spectrum space needed and the cost of retrofitting all base stations with new equipment. The availability of 2.5G systems with relatively fast data transmission has minimized the need for full 3G systems.

Some 3G systems are on the air and most cell phone companies using GSM will eventually evolve to the new WCDMA system. The CDMA2000 and WCDMA systems will coexist.

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